



Research Article

The use of flexible ureteroscopy is required to improve stone-free rates in ureteroscopy for proximal ureteral stones

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Received: 02 March, 2020

Accepted: 18 January, 2021

Published: 19 January, 2021

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Keywords: Flexible ureteroscopy; Ureteral stone; Stone free

<https://www.peertechz.com>



Abstract

Introduction: The main target in the treatment of proximal ureteral stones (PUS) is to provide a high stone-free rate (SFR) with low morbidity. In this study, we aimed to evaluate the need for flexible ureteroscopy (URS) by retrospectively examining one surgeon's two-year experience of URS for PUS in a center where the flexible ureteroscope and holmium laser lithotripter are available.

Patients and methods: The medical records of all patients who underwent URS due to PUS by a single surgeon from November 2016 to November 2018 were evaluated retrospectively. Success was accepted as patient with no stones or clinically insignificant residual fragments (<4 mm) observed at postoperative 4th and 8th weeks by radiological investigation.

Results: URS was performed for PUS in 49 renal units of 48 patients. The mean age was 41.5 ± 12. The operation was completed with pure semirigid URS without the use of flexible URS in 13 (26.5%) RUs. Even in stones with a distance of >5 cm to UPJ, two of nine stones required the use of flexible URS. 34 of 40 stones with a distance of <5 cm to UPJ required the use of flexible URS. 24 of 26 stones with a distance of <3 cm to UPJ required the use of flexible URS. Overall success rates were 100% (38/38) for pure PUS and 93.9% (46/49) for PUS with ipsilateral renal stones.

Conclusion: URS is a safe and successful treatment in PUSs. As we have shown in our data, if we want to achieve high SFR with low comorbidity, we should always have flexible URS in the operating room and should use it if necessary.

Introduction

The main target in the treatment of Proximal Ureteral Stones (PUS) is to provide a high Stone-Free Rate (SFR) with low morbidity. There are now many treatment options for PUS as the result of the development of endourological techniques. These are Extracorporeal Shock Wave Lithotripsy (ESWL), Ureteroscopy (URS) (semirigid-flexible, retrograde-antegrade), Percutaneous Nephrolithotomy (PNL), laparoscopic

ureterolithotomy, and open surgery. Today, percutaneous antegrade URS, laparoscopic ureterolithotomy, and open surgery provide a high SFR when used in a small number of special cases, while ESWL and URS constitute the standard treatment of PUS [1]. URS, which has the highest SFR in the treatment of PUS with the development of flexible ureteroscopes, is the first treatment option for stones >10 mm and is also the first treatment option with ESWL in stones <10 mm [2]. However, in developing countries, the flexible ureteroscope and holmium



laser lithotripter are not used due to their high costs, and the PUS may still have to be treated with a semirigid ureteroscope and pneumatic lithotripter [3]. In this study, we aimed to evaluate the need for flexible URS by retrospectively examining one surgeon's two-year experience of URS for PUS in a center where the flexible ureteroscope and holmium laser lithotripter are available. However, the flexible ureteroscope is not used in all PUS cases in order to extend the lifetime of the flexible ureteroscope due to economic considerations. We wanted to examine the SFR under these conditions.

Patients and methods

The medical records of all patients (48 patients, 49 renal units [RUs]) who underwent URS due to PUS by a single surgeon from November 2016 to November 2018 were evaluated retrospectively. The proximal ureter was defined as the part of the ureter between the Ureteropelvic Junction (UPJ) and the upper border of the sacroiliac joint. No specific exclusion criteria were applied.

All patients had a detailed medical history, physical examination, and laboratory tests, including renal function, complete urinalysis, and urine culture. All patients had Computed Tomography (CT) with stone protocol and plain X-ray of the Kidneys, Ureter and Bladder (KUB) on the morning of the operation. The location of the stone in all patients (as a distance from the UPJ), stone size, and the number of stones were recorded. In the postoperative period, all patients had a KUB on postoperative day one. Patients who had radiopaque stones had KUB and Ultrasonography (USG), and those who had radiolucent stones had CT in postoperative week 4. Patients who continued their follow-up for residual stones had USG in postoperative week 8.

Success was accepted as patient with no stones or clinically insignificant residual fragments (<4 mm) observed at postoperative 4th and 8th weeks by radiological investigation. The size of the stones was taken as the longest axis on the CT. In the patients with postoperative residual fragments, the longest size in KUB was taken for radiopaque stones, and the longest axis in CT was taken for radiolucent stones.

The operation technique was as follows. All patients underwent surgery under general anesthesia in the lithotomy position. One gr of ceftriaxone was given as preoperative antibiotic prophylaxis. Additionally, 6.0/7.5 French (Fr) (Richard Wolf, Germany) and 9.5 Fr (Karl Storz, Germany) were used as the semirigid URS. Flex-X2 (Karl Storz, Germany) was used as the flexible URS. In all patients, a semirigid ureteroscope was inserted into the ureter through a guidewire. At this stage, the patients with a narrow ureteral orifice were not entered and 4.7 Fr D/J catheters were placed, and the stone intervention was postponed after 3–4 weeks. In patients whose stone could be reached with semirigid URS, lithotripsy was performed with 30W holmium:YAG laser lithotripter (Richard Wolf). The use of an anti-retropulsion device (stone cone or basket) was decided at the case level during the operation. Clinically significant stone fragments were extracted. At the end of the operation, 4.7 Fr D/J or 5 Fr ureter catheters were placed, or no catheter was placed at the case level. We used

flexible URS in the following cases: when we went to UPJ with semirigid URS and did not see the stone because of push back to the kidney; when the stone or a significant fragment was pushed back to the kidney while performing lithotripsy with semirigid URS; when we could not reach the stone with semirigid URS due to ureteric kink, or if we reached the stone and we could not perform lithotripsy suitable for the stone due to the angle in the ureter; and in cases with ipsilateral kidney stones. The 9.5–11.5 Fr or 11–13 Fr ureteral access sheaths were used in patients when ureter calibration allowed. In the other patients, lithotripsy was performed with 30W holmium:YAG laser lithotripter (Richard Wolf) by entering sheathless into the renal collecting system with flexible URS via guidewire. Stone extraction was not performed in cases with flexible URS. A 272 µm laser fiber for flexible URS and a 550 µm laser fiber for semirigid URS with an energy output of 0.5–1.2 J at 8–15 Hz was used; but the J and Hz of energy could be changed during the operation according to the stone hardness and efficacy of lithotripsy. A 4.7 Fr D/J catheter was inserted in all patients who were operated with flexible URS.

A statistical analysis was performed. In this study, continuous variables were shown as mean ± Standard Deviation (SD). Categorical variables were shown as percentages. For the statistical analysis, Statistical Package for the Social Sciences version 15.0 (SPSS Chicago, IL, USA) was used.

Results

Patient and stone characteristics of 49 RUs are detailed in Table 1.

Table 1: Patient and stone characteristics.

Patients (n)	48
Renal Unit (n)	49
Age (years) (mean ± SD)	41.5 ± 12
Serum creatinine (mg/dl) (mean ± SD)	1.03 ± 0.24
Gender [n (%)]	
Female	18 (37.5)
Male	30 (62.5)
Side [n (%)]	
Right	25 (52)
Left	22 (46)
Bilateral	1 (2)
Stone radiopacity [n (%)]	
Radiopaque	41 (83.7)
Radiolucent	8 (16.3)
Hydronephrosis [n (%)]	
Grade 0	4 (8.2)
Grade 1	18 (36.7)
Grade 2	19 (38.8)
Grade 3	8 (16.3)
Distance from UPJ (mean ± SD) (mm)	32 ± 22
Length of stone (mean ± SD) (mm)	10.9 ± 4

Abbreviations: SD: Standard Deviation



Thirty-three (67.3%) RUs were referred to us by other urologists because of the necessity to use flexible URS. Three (6.1%) RUs had more than one PUS (two in two RUs, and three in one RU). Eleven (22.4%) RUs had ipsilateral renal calculi with PUS. Seven RUs (14.3%) underwent ESWL at another hospital that had an ESWL unit in the preoperative period but these failed. Two (4.1%) RUs had failed semirigid URS in the external unit and were referred to us because of the lack of flexible URS. Three (6.1%) RUs had D/J catheters inserted prior to ureteroscopy. A D/J catheter was inserted in two of them due to narrow ureter and in one due to lack of anesthesia because of thyroid dysfunction.

Ureteral stone distance from UPJ and usage of flexible URS summarized in Table 2. Even in stones with a distance of >5 cm to UPJ, two of nine stones required the use of flexible URS. 34 of 40 stones with a distance of <5 cm to UPJ required the use of flexible URS. 24 of 26 stones with a distance of <3 cm to UPJ required the use of flexible URS.

In 24 (49%) RUs operated with flexible URS (including 11 RUs with ipsilateral kidney stones), the lithotripsy was performed in the renal collecting system because of push back. In seven (14.3%) RUs operated with flexible URS, lithotripsy was initiated in the ureter with semirigid URS, but the lithotripsy was continued in the renal collecting system due to the stone or large fragments push back to the kidney. In three (6.1%) RUs operated with flexible URS, lithotripsy was initiated in the ureter with flexible URS, but the lithotripsy was continued in the renal collecting system because significant fragments were pushed back to the kidney. In two (4.1%) RUs operated with flexible URS, lithotripsy was performed in the ureter with flexible URS. A basket was used in only one (2%) patient (the first patient of the series) as a retropulsion device, but we did not use it again because we thought that its use at this level may cause serious ureteral complications such as ureteral perforation or uretral avulsion because of our inexperience with basket. Stone Cone (Boston Scientific Corp, Natick, MA, USA) was used in 12 RUs. Of these, 10 RUs were operated on only with semirigid URS. In two RUs that the Stone Cone was used in, significant fragments were pushed back to the kidney, and we used flexible URS. A ureteral access sheath was used in 20 (40.8%) RUs. In nine (18.4%) RUs, stones were anklave, and we used flexible URS in seven of these. We think that the possible cause of this is increased irrigation fluid pressure for a better view in anklave stones that, surrounded by mucosal edema and fragments, were pushed back with increased pressure because we could not pass the Stone Cone to proximal of anklave stones. D/J catheter was placed in 44 (89.8) RUs, and a ureter catheter was placed in four (8.2%) RUs. A catheter was not placed in one (2%) RU. In six (12.2%) RUs, simultaneous operation was performed on the contralateral RU (URS for two and RIRS for four).

Table 3 detailed gradual changes in success rates of ureteroscopy in postoperative 8 weeks. At the end of 8 weeks, overall success rates were 100% (38/38) for proximal ureter stones and 93.9% (46/49) for all stones.

Table 2: Stone distance from ureteropelvic junction and pure semirigid-flexible URS usage.

-URS type	-Stone distance	>5 cm to UPJ	<5 cm to UPJ	<3 cm to UPJ	
Pure Semirigit		7(%14,2)	6(%12,2)	2(%4,2)	13(26,5)
		2(%4,2)	34(%69,3)	24(%48,9)	36(%73,5)
Flexible*		9(%14,8)	40(%81,6)	26(%53,1)	total

Table 3: Success rates of ureteroscopy at the end of postoperative 8 weeks.

		Day 1	Week 4	Week 8
PUS with ipsilateral renal stones	Successful	43 (87.7)	46 (93.9)	46 (93.9)
	Stone free	33 (67.3)	42 (85.8)	45 (91.9)
	Clinically insignificant residual fragment	10 (20.4)	4 (8.1)	1 (2.0)
	Failed / Significant residual fragment	6 (12.3)	3 (6.1)	3 (6.1)
Pure PUS	Successful	37 (97.3)	38 (100)	38 (100)
	Stone free	31 (81.6)	36 (94.8)	37 (97.4)
	Clinically insignificant residual fragment	6 (15.7)	2 (5.2)	1 (2.6)
	Failed / Significant residual fragment	1 (2.6)	0	0

Abbreviations: PUS: Proximal Ureteral Stone

The hospital stay was median 1.6 (1–16) days. In total, 43 RUs were hospitalized for one day. One patient with preoperative severe urinary infection and two patients with postoperative urinary infection were hospitalized longer. D/J catheters were taken out after median 33.8 (19–84) days. Only one patient, the one with recurrent ureteral stricture, required additional intervention. We performed a laser endoscopic ureterotomy on this patient.

Complications occurred in nine (18.3%) RUs. Of these, six had mild hematuria (Clavien grade 1) that was treated conservatively. Two had postoperative urinary infection (Clavien grade 2). They consulted to infectious diseases and treated with antibiotics (no need for intensive care). One patient had ureteric stenosis, and balloon dilatation was performed. She had a 4 mm residual fragment at the stricture site in postoperative 4th week KUB and 8th week CT. Even though we kept the D/J catheter in this patient for 84 days, a more severe recurrent ureteral stricture (Clavien grade 3b) occurred. We performed a laser endoscopic ureterotomy for this patient and D/J catheter was taken out after 45 days. There was no obstruction in postoperative 3rd month DTPA scintigraphy and stone free in postoperative KUB and USG.

Discussion

Currently, URS is the first treatment option in PUS, according to European Association of Urology (EAU) guidelines, but we must inform our patients that ESWL is a treatment alternative in stones <10 mm [2]. We informed the appropriate patients that ESWL is a treatment alternative for them. In addition, we gave information about ESWL to patients who had >10 mm PUS and refused to go URS. We referred our patients who chose ESWL to another urology clinic because there is no ESWL unit at our clinic. We do not know the success of ESWL in these patients because no follow-up was available to us.

Of course, these recommendations suggest that URS is



recommended in all PUS, but it should be noted that this is a URS procedure including flexible ureteroscopes that have a small diameter and active deflection [4,5]. However, the cost of flexible ureteroscopes and holmium lasers for lithotripsy is very high, and these devices are not always available in developing countries [3]. In a study by Khairy-Hair, et al. they included patients who had 10–20 mm PUS. The SFR was 90.6% in postoperative week 2 and 98.6% in postoperative month 3 with semirigid URS and pneumatic lithotripsy [3]. In the Clinical Research Office of the Endourological Society (CROES) Ureteroscopy Study Group, 2656 RUs that underwent URS for PUS were evaluated. In URS for PUS, semirigid URS was used in 72.1% of the RUs, flexible URS was used in 11.2%, and both were used in 16.4%. In lithotripsy, holmium laser was used in 60.8% of the RUs, pneumatic was used in 27.5%, electrohydraulic, ultrasonic, or various combinations were used in the others. The SFR was 84.5% [6]. In their experience with semirigid URS and pneumatic lithotripsy, Yencilek, et al. achieved a success rate of 71.7% in the PUSs (7). In our study, we used semirigid URS, flexible URS (when necessary), and holmium laser (in all lithotripsies). Our SFR was 93.9%. When we excluded patients with ipsilateral kidney stones, our SFR was 100%. At this point, we were able to obtain a significant SFR difference when compared to the studies of the CROES ureteroscopy group (that most often used semirigid URS) and Yencilek, et al. (who only used semirigid URS) [6,7]. Interestingly, in the Khairy-Hair, et al. study (who only used semirigid URS), they had an SFR of 98.6%. Higher SFRs may be obtained with semirigid URS in more experienced centers; however, a SFR of 98.6% seems to be exaggerated. Comparative analysis studies seem to make more sense in comparing flexible URS and semirigid URS success. In the retrospective study of Karadag, et al. the SFRs were 93.4% in the flexible URS group and 77.7% in the semirigid URS group [8]. In the study by Galal, et al. the SFRs were 68% in the rigid URS group and 91% in the flexible URS group, and in the study by Alkan, et al. the SFRs were 76.5% in the rigid URS group and 87.5% in the flexible URS group [9,10]. In a multicenter prospective study by Hyams, et al. the SFR was 95% for PUS <2 cm operated with flexible URS. Again, in this study, the SFR was 100% for PUS <1 cm [11]. At this point, our SFR seems to be compatible with the literature. In our series, we started lithotripsies with semirigid URS in 20 (41.3%) RUs. In 13 (27%) of them, we were able to obtain a stone-free condition only with semirigid URS; in 7 (14.3%) of them, we continued lithotripsies in the renal collecting system with flexible URS because fragments were pushed back to the kidney. Even if we did not have flexible URS in these patients and would expect the stone fragments, which were pushed back, to spontaneous passage in the follow-up in most of them, we would have accomplished approximately a 40% SFR with semirigid URS. Even the SFR, which may occur by considering the best possibilities, appears to be far below the success rates of semirigid URS in the literature [7–10]. We think that this is related to the number of patients referred to us from other clinics (33 RUs, 67.3%) who may require flexible URS because of the fact that it is close to the UPJ in our series. Forty (81.6%) of the RUs in our series were <5 cm to the UPJ, and 26 (53.1%) were <3 cm to the UPJ. In clinics referring these patients, they

operated the proximal ureteral stones that were far from UPJ (less likely to push back to the kidney) with only semirigid URS. In addition, we could not see the medical records of these patients, so it was not possible to know how successful we would be using semirigid URS in PUS.

In some series, and perhaps even in our series, the highest SFRs seem to be related to the radiological evaluations we used for postoperative residual stone evaluation. There is a significant difference among investigating residual stones with KUB, USG, or CT [12,13]. However, in clinical practice, a new CT scan is often not possible due to avoiding the use of radiation on our patients who had CT in the preoperative period. If we could have evaluated all the patients with CT in the postoperative period, our SFR would probably have decreased, and the number of the RUs with significant or insignificant residual fragments would have increased. In a study conducted by the Endourology Disease Group for Excellence (EDGE) Research Consortium, in patients with <4 mm CIRFs which we included in the stone-free group, a re-intervention was required in 18% of the follow-ups, and the same was found for 19.6% in the study of Rebeck, et al. [14,15]. At this point, it is not entirely possible to say that we are fully successful in patients with residual fragments (even if they are CIRFs). In our study, it may be thought that because we did not do the stone extraction with a basket in the RUs and used flexible URS, this may have caused residual fragments, but in the study of the EDGE Research Consortium comparing dusting with basketing, the SFR in multivariate analysis was similar, and there was no significant difference in the number of patients who became symptomatic due to residual fragments in this study. However, the mean duration of surgery in the basketing group increased by 37.7 minutes [16]. We do not use baskets with flexible URS for stone extraction in our clinic.

In terms of complications, six (12.3%) patients had hematuria (Clavien grade 1) that was treated with conservative follow-up, two (4.1%) patients had urinary infection (Clavien grade 2) that was treated with postoperative hospitalization and antibiotic treatment, and one patient had recurrent ureteral stricture (Clavien grade 3b) that was treated with surgical intervention (laser endoscopic ureterotomy). None of our patients had Clavien grades 4 and 5 complications [17]. In most of the other studies, ureteral stricture was an exclusion criteria, so we did not see any recurrent ureteral strictures in these series [3,7,9–11]. In the CROES Ureteroscopy Study Group, 0.9% of their patients had ureteral stricture after ureteroscopy for PUS [6]. In the study of Hyams, et al. three (4.3%) patients had postoperative urinary infection after flexible URS for PUS, and two (4.1%) of our patients had postoperative urinary infection. In the study of Alkan, et al. ureteral perforation was seen in one patient, ureteral avulsion was seen in one patient in the semirigid URS group, and patients did not have these complications in the flexible URS group [10]. We did not see these two most frightening complications of ureteroscopy in our series; we think that the reason for this is we did not force patients to be operated with only semirigid URS and switched to flexible URS if necessary. Our complication rate seems to be compatible with the literature.



Conclusion

URS is a safe and successful treatment in PUSs. As we have shown in our data, if we want to achieve high SFR with low comorbidity, we should always have flexible URS in the operating room and should use it if necessary. Otherwise, it seems reasonable to refer patients to a nearby center that does have flexible URS.

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Citation: Bıçaklıoğlu F, Koparal MY, Bulut EC (2021) The use of flexible ureteroscopy is required to improve stone-free rates in ureteroscopy for proximal ureteral stones. *Arch Urol Res* 5(1): 001-005. DOI: <https://dx.doi.org/10.17352/aur.000028>